Question			Answer	Marks	Guidance	
1	(i)		$\mathbf{p} + \mathbf{q} = 28\mathbf{i} - 3.5\mathbf{j}$	B1		
			$28\mathbf{i} - 3.5\mathbf{j} = k(8\mathbf{i} - \mathbf{j})$ $k = 3.5$	M1 A1	Or equivalent. k may be implied by going straight to 3.5	
			(So they are parallel)			
			Alternative			
			$\mathbf{p} + \mathbf{q} = 28\mathbf{i} - 3.5\mathbf{j}$	B1		
			$\mathbf{p} + \mathbf{q}$: $\tan\theta = \frac{-3.5}{28} \Rightarrow \theta = -7.13°$ $8\mathbf{i} - \mathbf{j}$: $\tan\theta = \frac{-1}{8} \Rightarrow \theta = -7.13°$	M1	Comparing the ratio of the components in each of the two vectors is sufficient, using any consistent sign convention. The angle does not need to be worked out, nor does tan have to be seen.	
			So they are parallel	A1	Both ratios the same and correct	
				[3]		
	(ii)		$3\mathbf{p} + 10\mathbf{q} = (36+160)\mathbf{i} + (-15 + 15)\mathbf{j}$ $= 196\mathbf{i}$	B1		
			Zero **j** component so horizontal	B1	Or equivalent explanation. May be shown on a diagram	
				[2]		
	(iii)		The horizontal component must be zero			
			So $12k + 3\times 16 = 0 \Rightarrow k = -4$	B1	Substituting k = -4 and showing **i** component is zero is acceptable	
			$\mathbf{w}$ = -24.5**j**	B1	Award for 24.5 seen	
			$mg = 24.5 \Rightarrow m = 2.5$ The mass is 2.5 kg	B1	Award for 2.5 seen. FT from their weight.	
				[3]		

2	(i)		**P** + **Q** + **R** = 0**i** + 0**j**	B1 **[1]**	Accept answer zero (ie condone it not being in vector form)
	(ii)	*(A)*	The particle is in equilibrium	B1	If "equilibrium" is seen give B1 and ignore whatever else is written. Allow, instead, "acceleration is zero", "the particle has constant velocity" and other equivalent statements. Do not allow "The forces are balanced", "The particle is stationary" as complete answers
		(B)	The hiker returns to her starting point	B1 **[2]**	Do not allow "The hiker's displacement is zero"

		mark	notes
(3i)	$270 - \arctan\left(\frac{6}{4}\right)$ = 213.69… so 214°	M1 A1 2	Award for arctan p seen where $p = \pm\frac{6}{4}$ or $\frac{4}{6}$, or equivalent cao
(ii)	Need $(-4 + 3k)\mathbf{i} + (-6 - 2k)\mathbf{j} = \lambda(7\mathbf{i} - 9\mathbf{j})$ * **either** so $\frac{-4+3k}{-6-2k} = \frac{7}{-9}$. or equivalent $k = 6$ **or** $-4 + 3k = 7\lambda$ $-6 - 2k = -9\lambda$ $k = 6$ **trial and error method**	M1 M1 A1 A1 M1 **A1** A1 4	Attempt to get LHS in the direction of $(7\mathbf{i} - 9\mathbf{j})$. Could be done by finding (tangents of) angles. Accept the use of $\lambda = 1$. Attempt to solve **their** *. Allow = $\frac{7}{9}, \frac{9}{7}, -\frac{9}{7}$ Expression correct Award full marks for $k = 6$ found WWW Attempt to solve **their** *. Must have both equations. Correc equations Award full marks for $k = 6$ found WWW M1 any attempt to find the value of k and 'test' M1 Systematic attempt in (the equivalent of) **their** * Award full marks for $k = 6$ found WWW
		6	

		mark	comment	sub
4(i)	$\sqrt{10^2+24^2}=26$ so 26 N	B1		
	arctan ($10/24$)	M1	Using arctan or equiv. Accept arctan ($24/10$) or equiv.	
	= 22.619… so 22.6° (3 s. f.)		Accept 157.4°.	3
(ii)	**W** = $-w$ **j**	B1	Accept $\begin{pmatrix}0\\-w\end{pmatrix}$ and $\begin{pmatrix}0\\-w\mathrm{j}\end{pmatrix}$	1
(iii)	$\mathbf{T}_1 + \mathbf{T}_2 + \mathbf{W} = \mathbf{0}$	M1	Accept in any form and recovery from **W** = w **j**. Award if not explicit and part (ii) and **both** k and w correct.	
	$k = -10$	B1	Accept from wrong working.	
	$w = 34$	B1	Accept from wrong working but not – 34. [Accept – 10 **i** *or* 34 **j** but not both]	3
		7		

		mark	comment	sub
5(i)		B1	Sketch. O, **i**, **j** and **r** (only require correct quadrant.) Vectors must have arrows. Need not label **r**.	1
(ii)	$\sqrt{4^2+(-5)^2}$ = $\sqrt{41}$ or 6.4031… so 6.40 (3 s. f.) Need $180-\arctan\left(\frac{4}{5}\right)$ 141.340 so 141°	M1 A1 M1 A1	Accept $\sqrt{4^2-5^2}$ Or equivalent. Award for $\arctan\left(\pm\frac{4}{5}\right)$ or $\arctan\left(\pm\frac{5}{4}\right)$ or equivalent seen without 180 or 90. cao	4
(iii)	12**i** – 15**j** or $\begin{pmatrix}12\\-15\end{pmatrix}$	B1	Do not award for magnitude given as the answer. Penalise spurious notation by 1 mark at most once in paper	1
		6		

			mark		Sub
6	(i)	$\sqrt{(-6)^2+13^2} = 14.31782...$	M1	Accept $\sqrt{-6^2+13^2}$	
		so 14.3 N (3 s. f.)	A1		
					2
	(ii)	Resultant is $\begin{pmatrix}-6\\13\end{pmatrix}-\begin{pmatrix}-3\\5\end{pmatrix}=\begin{pmatrix}-3\\8\end{pmatrix}$	B1	May not be explicit. If diagram used it must have correct orientation. Give if final angle correct.	
		Require 270 + $\arctan\frac{8}{3}$	M1	Use of $\arctan\left(\pm\frac{8}{3}\right)$ or $\arctan\left(\pm\frac{3}{8}\right)$ ($\pm 20.6°$ or $\pm 69.4°$) or equivalent on **their** resultant	
		so 339.4439…° so 339°	A1	cao. Do not accept -21°.	
					3
	(iii)	$\begin{pmatrix}-3\\5\end{pmatrix} = 5\mathbf{a}$	M1	Use of N2L with accn *used* in vector form	
		so ($-0.6\,\mathbf{i} + \mathbf{j}$) m s^{-2}	A1	Any form. Units not required. isw.	
		change in velocity is ($-6\,\mathbf{i} + 10\,\mathbf{j}$) m s^{-1}	F1	$10\mathbf{a}$ seen. Units not required. Must be a vector. [SC1 for $a = \sqrt{3^2+5^2}/5 = 1.17$]	
					3
					8